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Biosphere 2
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LEO

Biosphere 2 Landscape Evolution Observatory

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Motivation

1. ***The need to understand how landscapes will be affected by future climate change***
2. ***The need to integrate across disciplines – Create Interdisciplinary collaborations to understand coupling among Earth Systems at and near the Earth's surface***
3. ***The need to create coupled Earth system computational models, and the idea that large-scale controlled experimentation might lead to better models***

First Major Renovation of Biosphere 2

1. *Farm soil was removed and related infrastructure was demolished*
2. *Intense planning sessions involving scientists from around the country and from many different science disciplines occurred during 2007-2009 to plan the new flagship project of Biosphere 2*
3. *It was decided to construct physical models of mountain slopes to study relationships among geology, hydrology, chemistry, ecology, and atmospheric science at a large scale – The Biosphere 2 Landscape Evolution Observatory*
4. *Construction is well underway and will finish by the end of 2012*

- *360 m^2 convergent hillslope forms*
- *1 meter of basaltic tephra ground to a loamy sand*
- *Thousands of environmental sensors to measure water, energy, carbon and geochemical fluxes through soil, plants, atmosphere*

What will we measure with sensors?

1. *Soil moisture*
2. *Soil water potential (water availability)*
3. *Soil temperature*
4. *Soil CO_2 concentration*
5. *Soil heat flux*
6. *Soil water saturation depth (to understand flow)*
7. *Atmospheric temperature, RH*
8. *Light and radiation*
9. *Precipitation*
10. *Soil water outflow*
11. *Total weight (~600,000 kg) for total moisture state*

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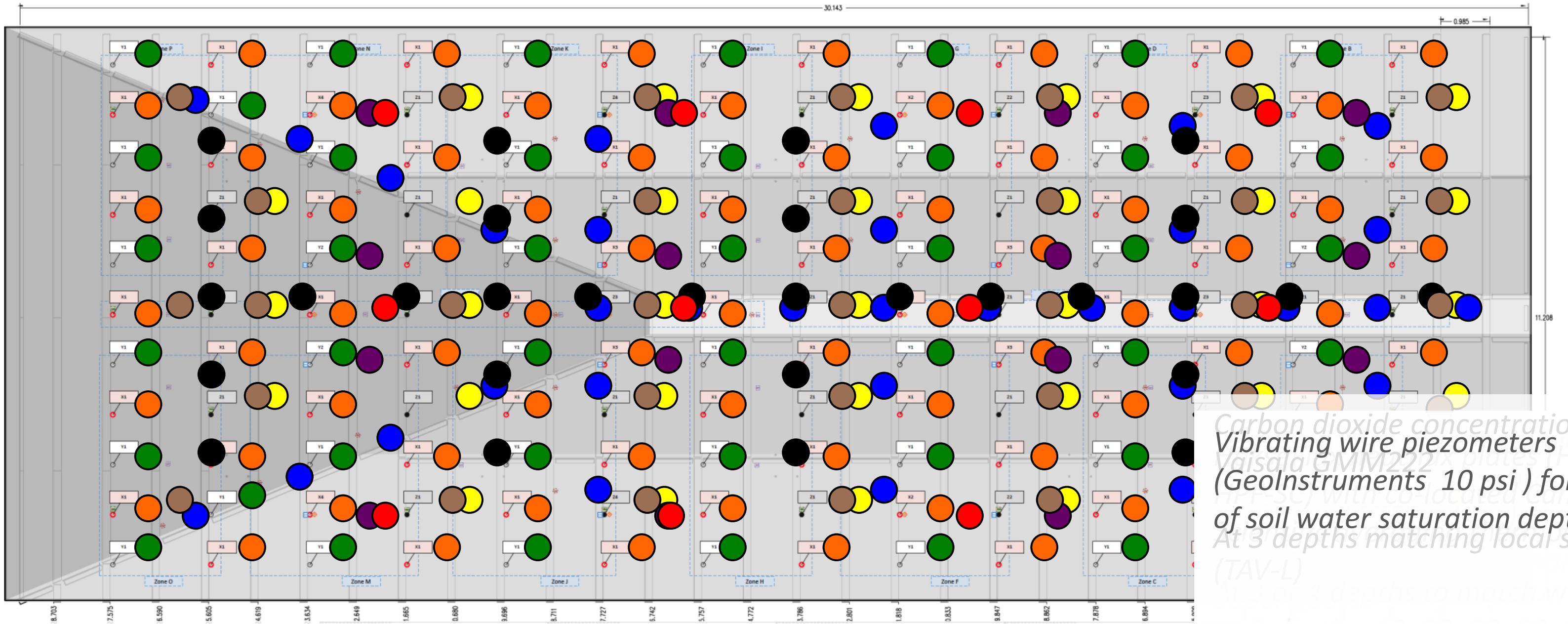

Vibrating wire piezometers (GeoInstruments 10 psi) for mapping of soil water saturation depths

Each LEO hillslope will have 1,835 sensors embedded in the "soil" material

What will we measure by sampling water and gas from the soil?

1. *Geochemical change (weathering) by analyzing dissolved elements in soil water*
   - *We expect minerals such as olivine and pyroxenes and also volcanic glass to weather to clays, changing the physical nature of the soil.*
2. *Soil water conductivity*
3. *Soil nutrients*
4. *Soil gas composition (CO_2, trace gases, VOCs, etc)*
5. *Tracer abundances (we will add tracers to the soil to study hydrological partitioning and water residence times)*
6. *Microbial and other biological activity (from water and gas chemistry)*

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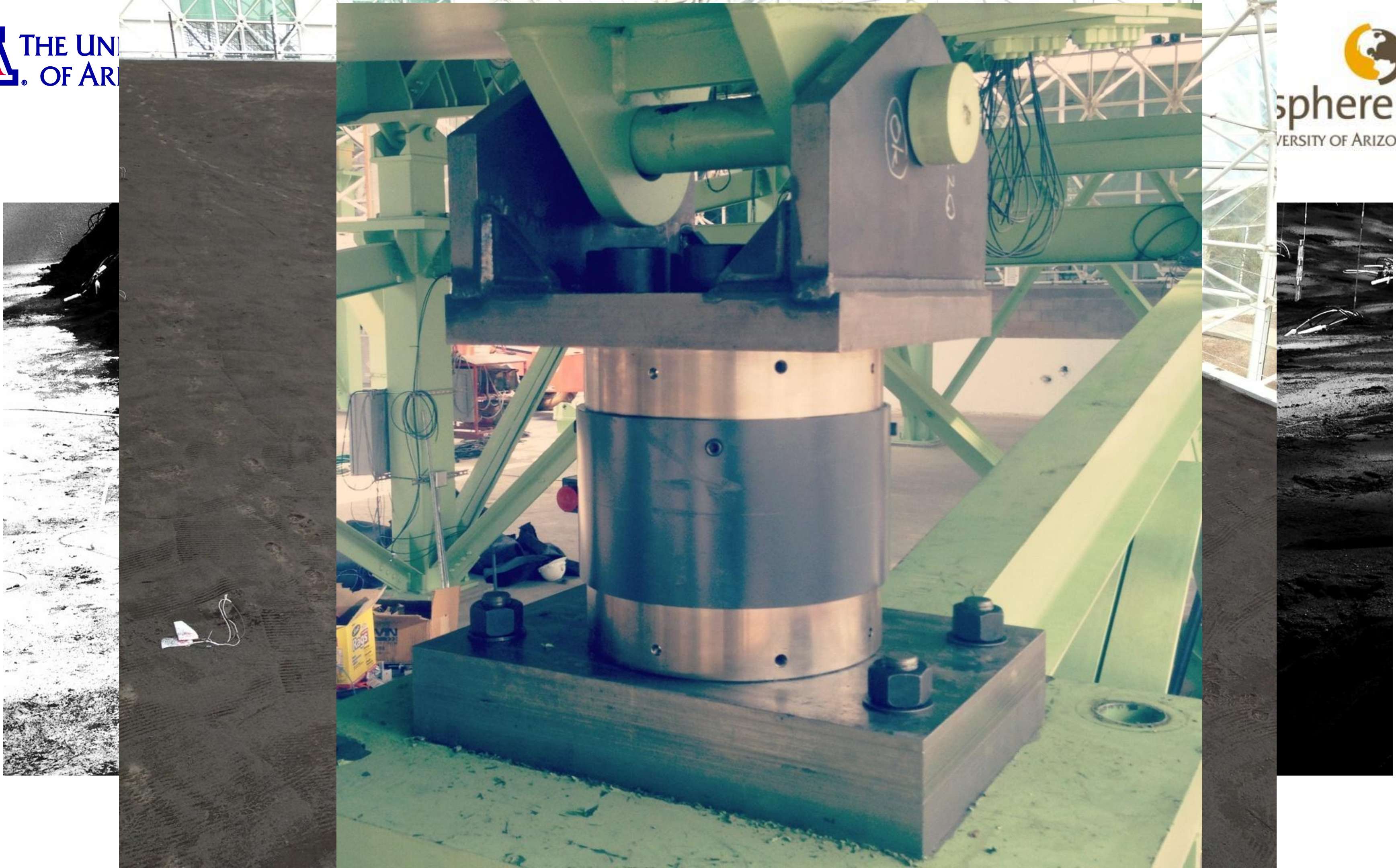

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East Slope Data

5TM Volumetric Water Content [%] on 2012-10-12 20:45:00

Level 1

Top — Down

6.16	3.03	4.1	4.9	7.62	5.99	6.23	5.79	6.56	2.95	7.49	6.16	8.27	6.46
2.01	6.9	7.06	6.76	6.73	3.21	5.41	4.9	-3.6	7.26	3.42	5.07	6.73	5.38
5.58	5.48	7.65	3.21	0.65	4.55	5.07	3.42	3.53	5.17	4.72	2.45	5.79	5.65
5.21	2.85	3.81	7.55	4.86	5.55	0.58	6.7	6.3	2.81	1.34	1.82	7.09	6.7
7.29	-0.27	5.89	0.35	-2.43	5.58	3.1	6.93	-2.76	5.35	-2.81	6.43	5.0	-1.66
5.52	5.0	5.14	-1.02	3.53	6.3	6.06	6.73	1.41	3.6	2.45	5.86	6.3	4.69
-9999.0	-9999.0	-1.82	-2.52	-1.46	6.26	4.9	5.48	5.24	6.03	-0.66	5.55	-2.43	6.86
-9999.0	-9999.0	4.55	5.45	-3.22	-0.04	7.46	5.82	-0.58	0.96	1.89	3.42	4.86	4.38
-9999.0	-9999.0	5.04	2.15	5.0	5.92	3.67	4.41	3.28	4.24	-4.86	2.08	3.06	5.79
-9999.0	-9999.0	5.31	5.07	6.96	1.56	-1.34	7.32	5.65	6.23	2.74	6.43	3.78	6.76
-9999.0	-9999.0	1.37	-0.98	5.35	5.69	1.03	2.34	-0.39	4.52	2.74	4.97	4.55	6.63

Level 2

Top

1.45	-1.14	-0.27	-2.06	-2.35	-2.6	-1.18	-1.06	1.41	-2.48	-2.35	-1.78	-1.86	-1.7
-1.86	1.34	1.45	-0.35	-2.19	-3.27	-2.56	-0.27	-3.69	-1.5	-1.02	-2.97	-2.31	-1.02
-2.85	-0.27	-0.15	0.46	0.96	-2.76	-2.43	-2.06	-1.42	2.12	-2.02	-0.7	-1.38	-1.46
-0.98	-1.06	1.89	1.45	0.27	-1.94	-1.42	-1.34	-0.62	-0.7	-1.42	-2.06	-1.9	[illegible]
-1.98	-1.14	-0.54	-0.66	1.37	-2.11	-2.93	-1.66	-0.58	-2.64	-1.58	-0.27	-1.66	[illegible]
-2.64	-0.94	-2.43	1.52	1.15	-0.43	-3.35	0.43	-0.19	-1.02	0.81	-1.82	1.11	[illegible]
-9999.0	-9999.0	-1.5	0.81	4.06	-1.62	-2.31	-0.04	0.39	-0.47	-1.5	-0.7	-1.46	[illegible]
-9999.0	-9999.0	0.88	1.22	0.77	-1.5	-0.7	-0.15	-9999.0	0.62	-3.06	-2.31	-2.93	[illegible]
-9999.0	-9999.0	-2.64	1.22	-1.38	-3.01	-2.23	-0.35	-9999.0	-1.74	-3.14	-2.76	-2.43	[illegible]
-9999.0	-9999.0	-3.95	-0.51	-0.62	-2.52	-2.11	2.45	-3.35	-1.62	-3.56	-3.27	-4.16	[illegible]
-9999.0	-9999.0	-3.44	-3.69	-1.66	-1.7	-1.98	-1.02	-2.68	-0.7	-0.86	-1.5	-2.02	[illegible]

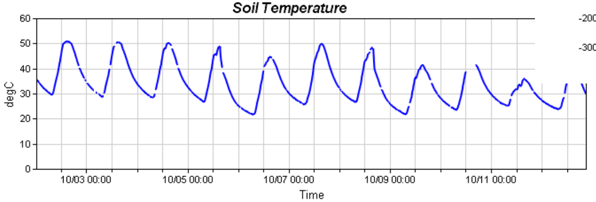
Level 3

	3.46		-0.31		4.1		2.04		0.58		2.59		[illegible]
0.43		0.35		2.08		1.37		1.34		-0.78		1.75	
	2.01		2.48		1.71		2.19		1.82		0.19		[illegible]

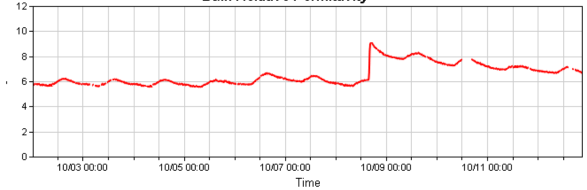
East Slope Data

Data Plots for SensorCode = LEO-E_22_-4_1_5TM

Soil Temperature



Bulk Relative Permittivity

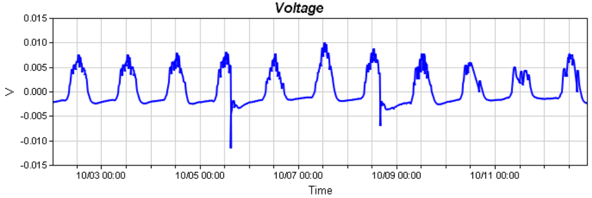


Volumetric Water Content

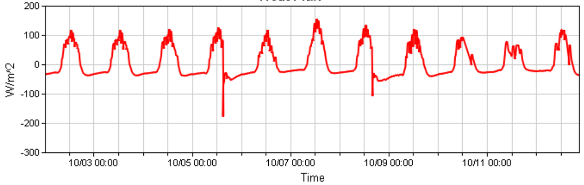
East Slope Data

Data Plots for SensorCode = LEO-E_12_4_1_HFP-1

Voltage



Heat Flux



What will the data tell us?

The data stream from LEO will allow us to quantify what happens to water after it enters the landscapes as rain. Water will go to surface runoff, into the soil, back to the atmosphere, into plants, into soil water storage and out of the soil at the downstream end.

This will allow us to develop and test ***new computational models*** *of how hydrology, geology, atmospheric science and ecology work together.*

These tools, together will give us ***new insight into the fate of water resources in future climate scenarios***

- ***Decision Support Tools: Coupled Computer Models of Earth Systems***

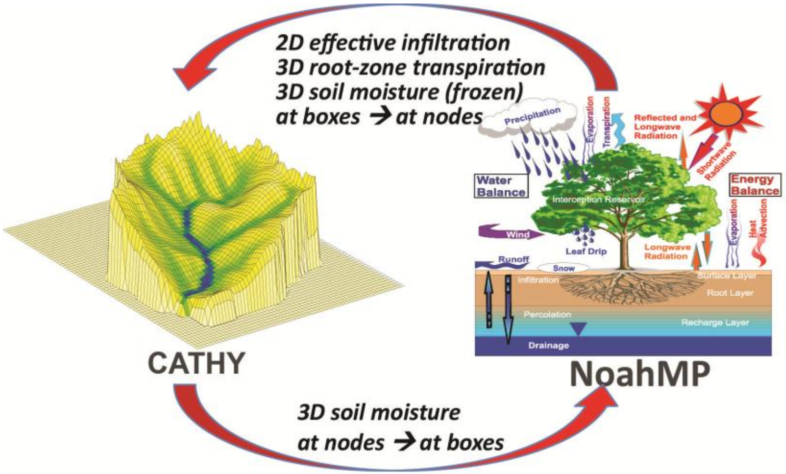


Figure 5. Schematic diagram showing the coupling between CATHY and NoahMP, which are coupled by exchanging fluxes and state variables. NoahMP transfers its effective infiltration (water incident at the soil surface minus evaporation) and root uptake from soil water by transpiration to CATHY, while CATHY transfers its soil moisture to NoahMP (from Niu et al. 2011b).

- ***What is the long term science plan?***

- *For the first year or two, the facility will be run without plants, so that we can understand the hydrology and soil chemistry in a simple state under a wide range of conditions and test our ability to predict hydrologic partitioning.*
- *After a year or so, we will add plants and observe how biological systems coevolve with physical systems.*
- *We will then run the system through a wide range of climate scenarios and develop collaborations between scientists from around the world to steer our research strategy.*

Follow the project

leo.b2science.org

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